Receiver Characteristics

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Future digital TV services place some requirements on the design of the next generation of TV receivers, which must be able to receive both analog and digital signals during a transition period of some length. The digital era probably will start with the launch of digital transmission systems over direct broadcast satellites such as DirecTV™. The next steps will be digital on cable and digital HDTV on terrestrial. For HDTV, different approaches are likely in the U.S. and in Europe. The U.S. is focusing on HDTV with a system under development in the Grand Alliance, whereas in Europe more emphasis is placed on multiprogram transmission and portability. The consequences of these choices will depend on the various display sizes.

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System Requirements

The digital signals will be processed through different steps. However, the method used to determine the split or the duplication of the various functions between the receiver, the recorder, and the set decoder is not an obvious choice.

The first implementation will use an add-on decoder, such as the one developed by Thomson for DirecTV. In that case there is no particular system issue and no difference noticed with the use of an add-on analog decoder (Fig. 1). These problems will have to be solved for HDTV, if some of the functions are to be integrated into the receiver. This will lead to the specification of digital interfaces.

Varying Displays and Costs

The display diagonal will probably cover a large range between 0.25 m (10 in.) and 1.50 m (60 in.), with some projectors permitting coverage of 2.50 m (100 in.). It is obvious that high-definition (HD) resolution will encourage the use of a larger screen than the current one. During the last ten years, one of the main figures for high definition was the 3-H factor (viewing distance for HD equal to 3 times the height of the display). This is an engineering concept.

Following increased experiences with consumers, two values for HD pictures on 16/9 screens can now be compared:

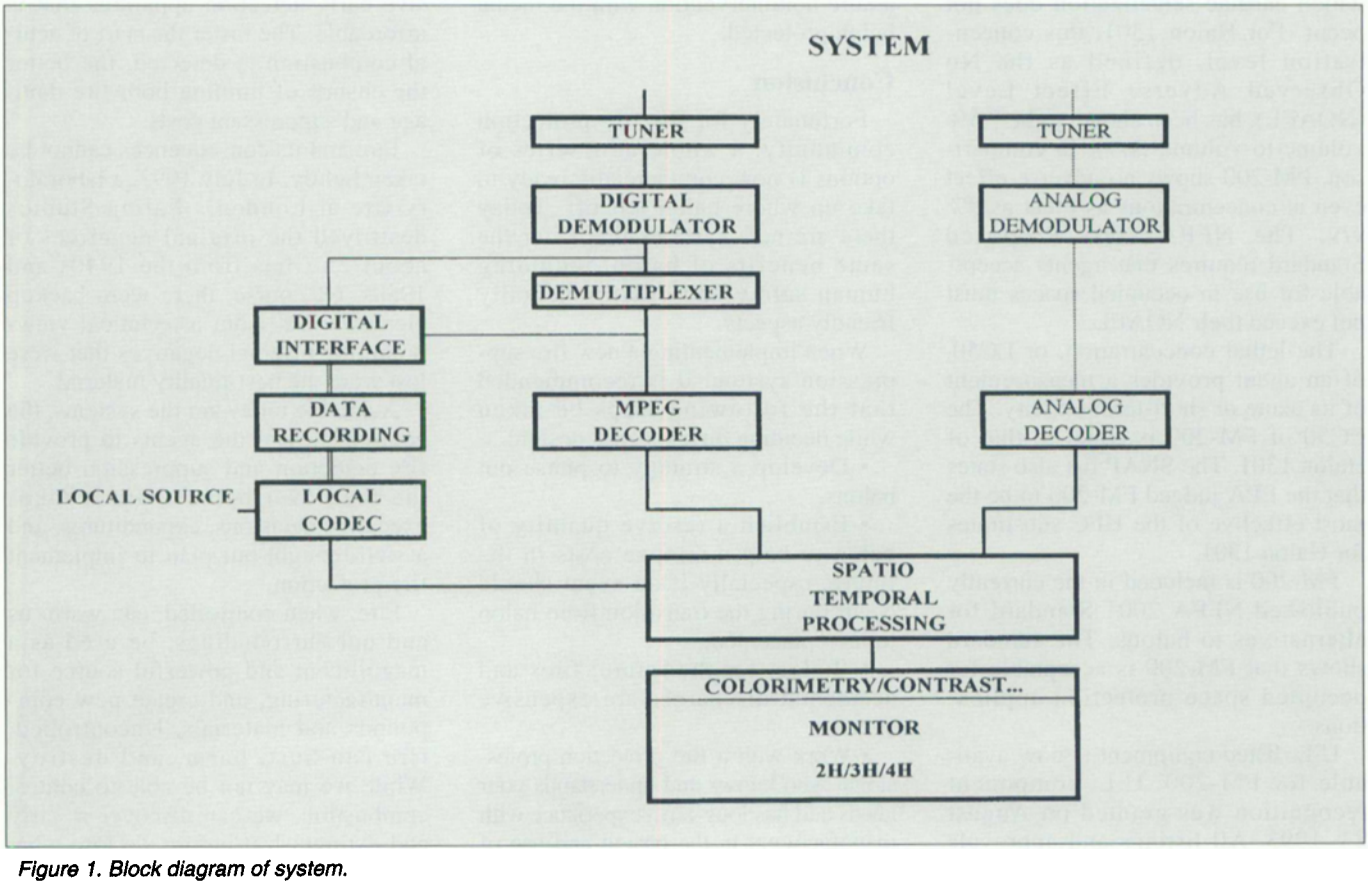
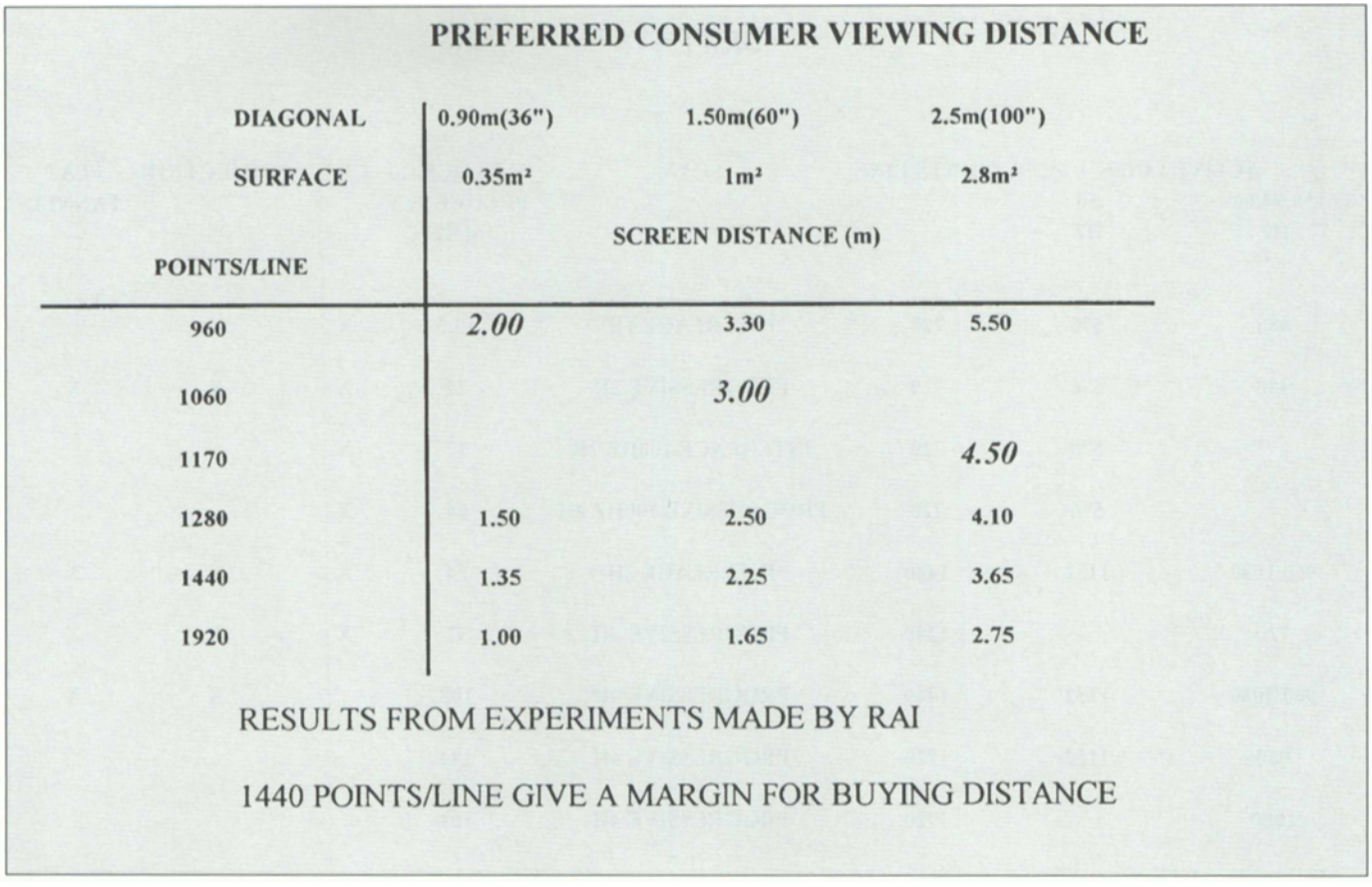


Figure 1. Block diagram of system.



PREFERRED CONSUMER VIEWING DISTANCE

DIAGONAL	0.90m(36")	1.50m(60")	2.5m(100")
SURFACE	0.35m²	1m²	2.8m²
	SCREEN DISTANCE (m)		
POINTS/LINE			
960	*2.00*	3.30	5.50
1060		*3.00*	
1170			*4.50*
1280	1.50	2.50	4.10
1440	1.35	2.25	3.65
1920	1.00	1.65	2.75

RESULTS FROM EXPERIMENTS MADE BY RAI

1440 POINTS/LINE GIVE A MARGIN FOR BUYING DISTANCE

Figure 2. Preferred consumer viewing distance.

- Screen distances needed for various numbers of points per line
- Preferred consumer viewing distance (Fig. 2)

These data seem to indicate that when given the choice of the distance for viewing HD pictures on large screens, the consumer does not opt for 3 H but remains between 4 H and 3.5 H, depending on the screen size. This gives us an idea of the trade-off that consumers are ready to accept in terms of resolution: 1440 pts/line will largely cover the needs for home use.

Adapted Processing

The variety of display sizes will lead to different technologies (Fig. 3). Direct-view cathode ray tubes (CRTs) cover the range from 0.25 m (10 in.) to 1.00 m (40 in.); rear projectors or projectors are used in the upper range. Flat panels will be used in the lower range for portability; in that case very low power consumption is required. In the upper range, liquid crystal display (LCD) projectors that necessitate progressive pictures are coming onto the market.

There will therefore be different signal-processing needs, based on the principle of a unique display format in the receiver for different input formats. The main requirements can be classified into three categories:

- HD display for standard definition
- Progressive LCD display for interlaced sources
- Display rate increase to avoid large-area flicker

This will be done through a combination of processing optimized for each display technology, including:

- Horizontal interpolation
- Vertical interpolation
- Temporal interpolation
- Motion detection

It is clear that compressed digital signals have an advantage due to the existence of motion vectors.

One important factor in this spatiotemporal processing is the clock rate. Today the technology of the 2-H chassis sold for progressive or 100-Hz display uses a clock rate of 27 MHz and is already expensive. (100 Hz is double field rate display to avoid flicker.) With HDTV or a combination of progressive and 100-Hz display, clock rates will be in the range of 54 to 108 MHz; this will necessitate a new technology for such consumer products as the TV chassis. The increase in power consumption and radiation is a real problem in consumer TV receivers.

Digital Compression

The most important factor regarding integration of the digital decoder into the receiver is standardization. Fortunately, the use of MPEG-type decoding and demultiplexing is gaining broad acceptance. This evolving world standard on digital encoding offers a means to cost-effective implementation. Hierarchical systems or simulcast will probably permit optimizing the decoding of HD signals in small receivers.

Demodulation

In each transmission mode, optimization of available data rate will lend itself to different modulation

DISPLAYS

ACTIVE LINES 59.94/60 HZ	ACTIVE LINES 50 HZ	POINTS/LINE	SCAN	CLOCK FREQUENCY MHZ	CRT	PROJECTION	FLAT PANNEL
480	576	720	INTERLACE 1H	13.5	X	X	
480	576	720	PROGRESSIVE 2H	27	X	X	X
	576	720	INTERLACE 100HZ 2H	27	X		
	576	720	PROGRESSIVE 100HZ 4H	54	X		
960/1080	1152	1440	INTERLACE 2H	54	X	X	X
720		1280	PROGRESSIVE 3H	72	X	X	X
960/1080	1152	1440	PROGRESSIVE 4H	108		X	X
960	1152	1920	PROGRESSIVE 4H	144			
1080		1920	PROGRESSIVE 4H	162			

Figure 3. Various display sizes and technologies.

schemes. This is obvious if one considers various supports and the need to maximize useful data rate in these channels. More complex electronics will be required if it is necessary to cover satellite, cable, and terrestrial service in the same receiver.

It is well known that future tuners will have to be more complex than current analog ones in order to receive digital signals, particularly in terrestrial service with the existence of co-channels. This will lead to the use of a double-conversion tuner, which produces better linearities in the total bandwidth with little increase in cost.

Interfaces

The number of different inputs for the receiver is increasing due to the coexistence of the new signals with the older ones. Nevertheless, the main question concerns the interface with digital recording. A conference for the standardization of a HD digital VCR was begun in September 1993, with the goal of a complete specification by the end of 1994, including advanced television (ATV) interface.

This digital VCR will have a useful video data of 25 Mbits in standard-definition (SD) mode, or 50 Mbits in HD mode. Due to trick modes and the need of a local encoder the compression used is different from MPEG 2; however, it will also offer a data stream mode permitting the recording of MPEG 2 with the use of time shifting. This can result in a unique prerecorded software based on MPEG 2. The use of MPEG in HD will require only the 25-Mbit/sec VCR mode. The problem is how to process encrypted video and preselected programs recording when the 25 Mbits/sec can contain five to ten different programs, as in DirecTV.

Conclusion

Receiver characteristics must take into account the progress of the technology but nevertheless remain at a price level where the consumer is ready to accept the trade-off in performance versus service. The near availability of digital recorders, combined with digital transmission, will define completely new services at home. Receiver characteristics have to be optimized with these services in mind, and not only for the classic hardware compromise between performance and cost.

The first consumer digital decoders came on the market in early 1994. Integration of digital decoders inside the receiver will depend greatly on the existence of standards. This standardization process mainly concerns compression and transport. We look forward to the success of MPEG 2, which could permit the use of the same software on all the transmission paths, including VCRs, even if each support used its own f-optimized modulation scheme. Manufacturers are already working to adapt receiver characteristics to this new era.